NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY
DEPARTMENT OF APPLIED CHEMISTRY
END OF FIRST SEMESTER EXAMINATIONS – APRIL/MAY 2009
PHYSICAL CHEMISTRY FOR ENGINEERS – SCH 1120
TIME: (3) THREE HOURS

INSTRUCTIONS TO CANDIDATES

MATERIAL
Reduction potential tables, graph papers.

INSTRUCTIONS TO STUDENTS
Answer All questions in section A and Any Three questions in Section B.
Answer each question on a FRESH page.

$R = 8.314\ JK^{-1}mol^{-1} = 0.08205\ dm^3atmK^{-1}mol^{-1}$.
$F = eN_A = 96500\ C\ mol^{-1}$
1 atm = 760 torr = 760mmHg = 101 325 Pa
lnx = 3.303logx

SECTION A *Answer ALL questions. Each question carries 10 marks*

1. (a) The molar conductivity of 0.1M KCI(aq) at 298K is 129 S cm^2 mol^{-1}. The measured resistance in a conductivity cell was 28.44Ω. When the same cell contained 0.05M NaOH(aq) the resistance was 31.6Ω. Calculate the molar conductivity of NaOH(aq) at that temperature and concentration. [4 marks]

(b) The limiting molar conductivities of KCl, KNO_3, and $AgNO_3$ at standard conditions are 149.9 S cm^2 mol^{-1}, 145.0 S cm^2 mol^{-1}, and 133.4 S cm^2 mol^{-1}, respectively. What is the limiting molar conductivity of AgCl at this temperature? [4 marks]

(c) State the two effects which are collectively known as the Retardation effects in strong electrolytes. [2 marks]

2. (a) State the four common kinds of electrodes used in electrochemical cells. [4 marks]

(b) Write the equation for the interfacial potential difference for each of them [4 marks]

(c) State the two types of concentration cells and highlight the major difference between them [2 marks]

3. (a) Compare and contrast Langmuir and BET adsorption isotherms? [6 marks]

(b) State the three basic assumptions of the Langmuir's adsorption isotherm. [4 marks]

4. (a) What is a colligative property [2 marks]

(b) State the four colligative properties of dilute solutions and for any two of them, name the analytical methods in which they are used [4 marks]

(c) Calculate the osmotic pressure of a sucrose solution of concentration 0.05 $moldm^{-3}$ at 303K. [4 marks]

SECTION B

Answer ONLY THREE questions from this section.

5. (a) The cell Mg | Mg SO_4(aq, a =1) || $CuSO_4$(aq, a = 1)| Cu was set up in a laboratory experiment.

Calculate (i) the e.m.f of the cell at standard conditions
(ii) the value of ΔG_r^{Θ} for the cell reaction
(iii) the equilibrium constant for the cell reaction.

Which electrode is more positive, and which way do electrons flow? [8 marks]

(b) Write the cell reactions and half-reactions for the following cells:
(i) Sn | $SnCl_2$(aq) || $MnCl_2$(aq), HCl(aq) | MnO_2(s) | Pt
(ii) Pt| Fe^{3+}(aq), Fe^{2+}(aq)|| Sn^{4+}(aq) | Sn^{2+}(aq) | Pt [6 marks]

(c) Using electrode potentials, calculate the equilibrium constant for the following reactions at 25°C.
(i) $Sn(s) + SnCl_4(aq) \longrightarrow 2SnCl_2(aq)$
(ii) $Sn(s) + 2AgCl(s) \longrightarrow SnCl_2(aq) + 2Ag(s)$
[6 marks]

7. The data below relates to the adsorption of carbon monoxide on charcoal at 273K. Confirm that they fit the Langmuir isotherm, and find:
(a) The constant k
(b)The volume corresponding to complete coverage

In each case V has been corrected to 1 atm

P/Torr	100	200	300	400	500	600	700
V/cm^3	10.2	18.6	25.5	31.5	36.9	41.6	46.1

The Langmuir's isotherm: $\Theta = kP/(1+kP)$ [20 marks]

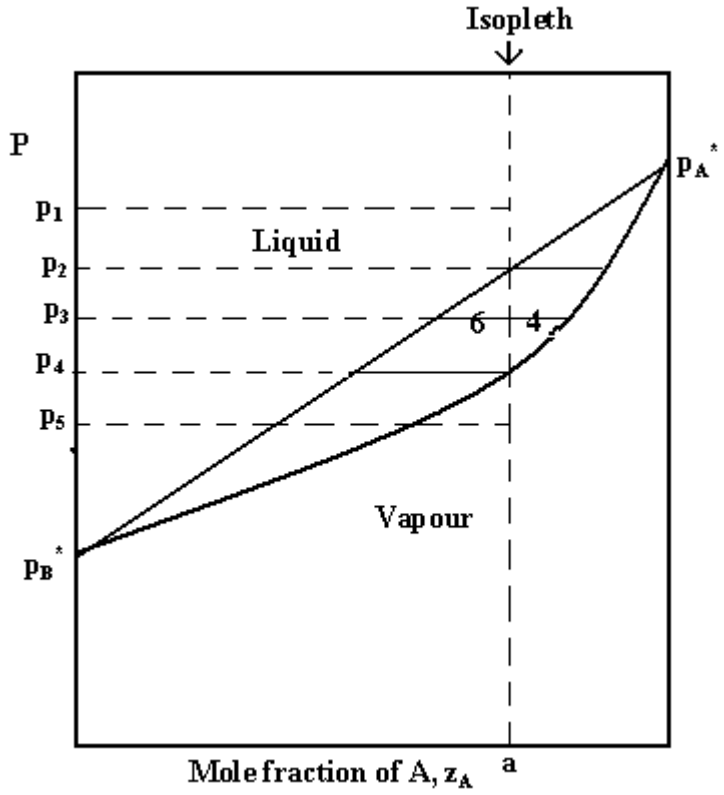
8. (a) At 353K the vapour pressures of two liquids A and B which are completely miscible and form an ideal solution are 757 and 66 mmHg, respectively. For an equimolar mixture [$x_A = x_B = 0.5$] calculate the total vapour pressure and the mole fraction of A in the vapour phases. Assume that the mixture follows Raoult's Law. [4 marks]

(b) Calculate the estimate mole fractions (x_A, x_B, y_A, y_B) in the respective phases at equilibrium when the total pressure of the solution is 500mmHg [8 marks]

(c) Calculate the estimate mole fractions (x_A, x_B, y_B) in the respective phases, and also the total vapour pressure when y_A (the mole fraction of A in the vapour phase at equilibrium with the liquid mixture) is fixed at 0.8. [8 marks]

9. (a) The figure below is a pressure – composition diagram a mixture of two volatile liquids A and B. Copy the diagram and use it as you describe in detail what will be observed when the pressure of a system of composition $z_A = a$ is reduced from P_1 to P_5 along the Isopleth, At each pressure indicated give the number of phases, the equilibrium composition of the phases (use notation of your choice), and the relative amounts of the phases

[10 marks]



(b) Write the Phase rule and define each of the three variable terms in it [8 marks]

(d) What is a constituent in a system? [2 marks]

END OF QUESTION PAPER!!